

CO₂ Sequestration Options, Costs and Impacts

Edward S. Rubin
Department of Engineering and Public Policy
Carnegie Mellon University
Pittsburgh, PA, USA
Email: rubin@cmu.edu
Tel: (412) 268-5897; Fax: (412) 268-1089

Abstract

CO₂ capture and sequestration (or storage) (CCS) is receiving considerable international attention as a potential greenhouse gas mitigation option that can allow continued use of fossil fuels with little emissions of CO₂ to the atmosphere, and thus enable a smoother, less costly transition to a sustainable (low-carbon) energy future. This paper reviews the major CCS options for new and existing power plants, include natural gas combined cycle plants (NGCC), pulverized coal-fired plants (PC), and integrated coal gasification combined cycle plants (IGCC). Power generation costs with and without CCS are summarized for each major system based on a survey of the recent literature. Based on current technology, NGCC plants typically provide the lowest-cost electricity with or without CCS for gas prices up to about \$4/GJ, while coal-based IGCC plants with CCS are generally projected to be less costly than comparable PC plants with capture for bituminous coals. However, for each of these systems, the cost of providing low-carbon power depends upon a host of technical and economic factors related to the power plant design, the fuel used, the capture technology employed, and the methods of CO₂ transport and storage. A generalized modeling tool is presented to facilitate comparative cost estimates that account for key site-specific variables. The model also is used to assess and compare the multi-media environmental emissions and resource requirements of NGCC, PC and IGCC plants on a systematic basis. This analysis highlights the importance of CCS energy requirements on plant-level impacts. While some CCS technologies offer ancillary benefits via the co-capture of criteria air pollutants like SO₂ and NO₂, the loss of plant efficiency due to CCS energy requirements results in often sizeable increases in fuel consumption, reagent use, solid wastes and air pollutant emissions per unit of electricity generated compared to the same plant without CCS. Thus, the development of advanced technologies that can minimize CCS energy penalties, as well as cost, is important for achieving environmental goals for air pollution and climate change.